LINKING BUILDING PROPERTIES TO EARTHQUAKE-INDUCED DAMAGE AND BUSINESS DOWNTIME USING FEMA P-58 AND REDI ASSESSMENTS

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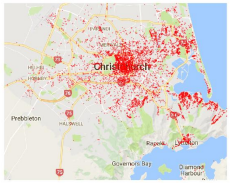
1. Inputs

Building Properties

Obtained from the Christchurch Earthquake Building Assessment (CEBA) database

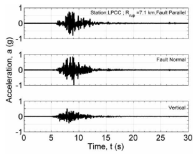


Building Properties used for this project:
- Building Age
- Building Period
- Building Type and Lateral System (e.g. Reinforced Concrete Shear Wall)
- Number of stories
- Floor Footprint Area

Ground Motion

Used ground motions for the **M6.2 22 February 2011 Christchurch Earthquake**

Obtained for each building from Bradley (2012)



Bradley, B. A. "Ground motions observed in the Darfield and Christchurch earthquakes and the importance of local site response effects." *New Zealand Journal of Geology and Geophysics* 55.3 (2012): 279-286.

Introduction

The 2010-2011 Canterbury earthquake sequence, and the resulting extensive data sets on damaged buildings that have been collected, provide a unique opportunity to exercise and evaluate previously published seismic performance assessment procedures.

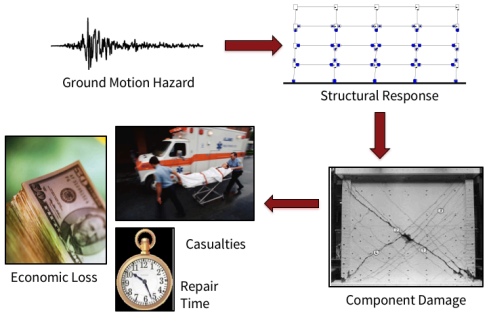
This poster provides an overview of the authors' methodology to perform evaluations with two such assessment procedures, namely the P-58 guidelines and the REDi Rating System. P-58, produced by the Federal Emergency Management Agency (FEMA) in the United States, aims to facilitate risk assessment and decision-making by quantifying earthquake ground shaking, structural demands, component damage and resulting consequences in a logical framework. The REDi framework, developed by the engineering firm ARUP, aids stakeholders in implementing resilience-based earthquake design.

Preliminary results from the evaluations are presented. These have the potential to provide insights on the ability of the assessment procedures to predict impacts using "real-world" data. However, further work remains to critically analyse these results and to broaden the scope of buildings studied and of impacts predicted.

2. Calculations

FEMA P-58 & REDi Assessments

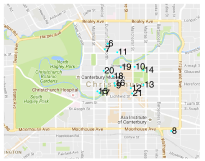
The FEMA P-58 Methodology is a probabilistic prediction methodology for evaluating building performance under earthquake loads.



The REDi framework is a resilience-based design initiative that measures building performance in terms of a modified version of the P-58 Methodology, involving a more complex repair time calculation.

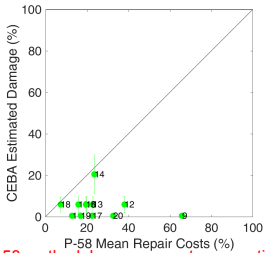
3. Outputs

P-58 Repair Cost

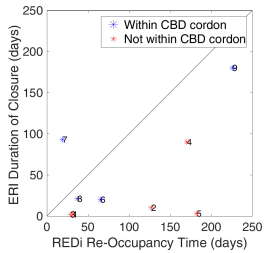


REDi Downtime

Comparisons



The P-58 methodology appears to overestimate repair costs. However, there are significant limitations to this initial analysis, which future efforts will attempt to eliminate.



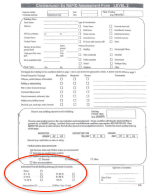
Comparisons

The REDi methodology generally appears to predict larger downtimes than those recorded. Future work will address this issue in more detail.

4. Benchmarks

Building Damage Benchmark

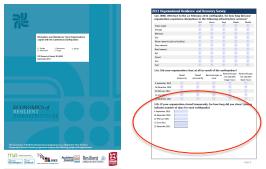
% Building Damage field of the CEBA database, collected during Building Safety Evaluation (tagging) procedures



The ratio reflects the extent of building volume damaged, rather than the repair cost as a percentage of building value –it is an initial imperfect proxy for repair cost.

Building Downtime Benchmark

Organisations' Duration of Closure due to the Christchurch Earthquake, as captured in the Economics of Resilient Infrastructure (ERI) survey



The ERI project captured survey data for over 500 organisations across Christchurch in 2013, on over 200 variables including organisation demographics and impact measures.

Challenges with Data & Possible Strategies to overcome them

To ensure consistency of the downtime comparison metrics in particular, buildings used for the analyses should adhere to the following criteria:
- Tenant organisation does not have >1 location
- Tenant organisation did not relocate as a result of the 22 February 2011 earthquake
- Building is not located within an area that was ever within the confines of the CBD cordon

Unfortunately, there is a lack of building property and/or downtime data available for buildings that satisfy these criteria

Possible strategies to gather such data that will be looked into in the future include:
- Visually inspecting relevant buildings to obtain building property information
- Conducting phone call interviews with tenants of relevant buildings to determine their earthquake-induced duration of closure
- Contacting Canterbury Employers' Chamber of Commerce to collect information on appropriate tenant organisations